

INDOOR AIR QUALITY ASSESSMENT

**Lanesborough Elementary School
188 Summer Street
Lanesborough, Massachusetts**



Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
Emergency Response/Indoor Air Quality Program
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Background/Introduction

At the request of the John Olander, Lanesborough Board of Health an indoor air quality assessment was done at the Lanesborough Elementary School (LES), 188 Summer Street, Lanesborough, Massachusetts. This assessment was conducted by the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA). On February 27, 2003, a visit was made to this school by Mike Feeney, Director of the Emergency Response/Indoor Air Quality Program (ER/IAQ) Program, BEHA to conduct an indoor air quality assessment. Mr. Feeney was accompanied for portions of the assessment by Mr. Olander. This request was prompted by indoor air quality issues concerning sewer gas odors reported in the school.

The original building is a single-story, red brick building constructed in 2001. The school contains general classrooms, media center, computer room, music room, gymnasium, cafeteria and office space. An open courtyard is located at the center of the building. Windows are openable throughout the school.

Methods

Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551.

Results

The LES houses pre-kindergarten through sixth grade students with a student population of approximately 300 and a staff of approximately 30. The tests were taken during normal operations at the school. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 parts per million parts of air (ppm) in one of twenty-three areas surveyed, indicating adequate fresh air ventilation in most areas of the school. It should be noted however, that a number of areas throughout the school were sparsely populated during the assessment, which can greatly contribute to reduced carbon dioxide levels.

Fresh air in classrooms is supplied by a mechanical unit ventilator (univent) system. A univent draws fresh air from a vent on the exterior of the building and air from the classroom (called return air) through a vent in the base of its case (see [Figure 1](#)). Fresh air and return air are mixed, filtered, heated and provided to classrooms through a fresh air diffuser located in the top of the case. Univents were operating during the assessment. Obstructions to airflow, such as shelves and carpet squares in front of return vents were noted in classrooms (see Picture 1). In order for univents to provide fresh air as designed, univent air diffusers and return vents must remain free of obstructions. Wall-mounted intake grills connected to ductwork provide mechanical exhaust ventilation. These vents were functioning during the assessment.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a univent and exhaust system, these systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air. It was reported that the last balancing of these systems was prior to the opening of the school in 2001. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each

room (BOCA, 1993; SBBRS, 1997). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this occurs a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please see [Appendix I](#).

Univent filters are designed to strain particulates from airflow. Air filters in univents at the LES provide minimal filtration of respirable dust. In order to decrease aerosolized particulates, disposable filters with an increased dust spot efficiency can be installed. The dust spot efficiency is the ability of a filter to remove particulates of a certain diameter from air passing through the filter. Filters that have been determined by ASHRAE to meet its standard for a dust spot efficiency of a minimum of 40 percent would be

sufficient to reduce airborne particulates (Thornburg, 2000; MEHRC, 1997; ASHRAE, 1992). Note that increased filtration can reduce airflow produced by increased resistance (called pressure drop). Prior to any increase of filtration, each piece of air handling equipment should be evaluated by a ventilation engineer to ascertain whether AHUs can maintain function with filters that are more efficient.

Temperature readings were within a range of 66⁰F to 74⁰F, and most areas had temperature readings within BEHA's recommended comfort guidelines. The BEHA recommends that indoor air temperatures be maintained in a range of 70⁰F to 78⁰F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity in the building was below the BEHA recommended comfort range in all areas surveyed. Relative humidity measurements ranged from 12 to 18 percent. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

Several classrooms had a number of plants. Moistened plant soil and drip pans can serve as a source of mold growth. Plants should be equipped with drip pans and located away from univents to prevent the aerosolization of dirt, pollen or mold.

Other Concerns

As mentioned previously, sewer gas odors were reported in some classrooms. In order to ascertain the source of such odors, an evaluation of rooftop equipment was conducted. Of note is the configuration of the roof. The roof has an upper and lower section. The upper section is formed by a sloped roof that is pitched towards the exterior wall of the building (see Picture 2). In place of a sloped roof pitched inward towards the courtyard on the lower section, a flat roof was installed (see Picture 3). The intent of this design is to prevent the diversion of rainwater from the roof into the courtyard. A number of building components are installed on the lower roof, including exhaust vents, fresh air intakes and sewer vent pipes. One classroom with reports of chronic sewer gas odor is located off the east wall of the courtyard. This classroom has its univent installed within the suspended ceiling, with the return vent located near the window. The fresh air supply for the univent is a roof vent gravity intake (see Picture 4). Located in the same vicinity of the gravity intake vent is a sewer vent pipe. Under certain weather condition characterized by heavy precipitation into the buildings septic system, pressurization of the system can force odors out of sewer vent pipes on the rooftop. Sewer gas is heavier than air and would be expected to sink toward the roof surface where it can be drawn into this classroom as the univent operates. A secondary pathway for sewer odors may be through this classrooms' windows system. Significant drafts were penetrating into the classroom around window frames at the time of the assessment.

The classroom located in the northeast corner of the school also reported sewer gas odors. An open section of interior wall was noted underneath the classroom sink (see Picture 5). If the septic system becomes pressurized, a leak in the plug or seam in the pipe may force sewer odors into this classroom.

Another possible source of sewer odors are science classrooms equipped with bubbler type eyewash stations. Each of these eye wash stations is equipped with a drain trap. Without periodic water poured into the drain, the traps on the eye wash station may dry out, which can result in sewer gas migration into science classrooms. Sewer gas can contain hydrogen sulfide, which is an irritant to the eyes, nose and respiratory system.

In an effort to reduce noise from sliding chairs, tennis balls are sliced open and placed on chair legs (see Picture 6). Constant wearing of tennis balls can produce fibers and result in off gassing of materials. Tennis balls are made with a natural rubber latex bladder, which becomes abraded when used as a chair leg pad. Use of tennis balls in this manner may introduce latex dust into the school environment. Some individuals are highly allergic to latex (e.g. spina bifida patients) (SBAA, 2001). It is recommended that the use of materials containing latex be limited in buildings to reduce the likelihood of symptoms in sensitive individuals (NIOSH, 1997). A question and answer sheet concerning latex allergy is attached as [Appendix II](#) (NIOSH, 1998).

A number of classrooms contained dry erase boards and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners may contain volatile organic compounds (VOCs), such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999). Dry erase board markers can be irritating to the eyes, nose and throat.

Conclusions/Recommendations

In view of the findings at the time of the visit, the following recommendations are made:

1. An extension of the sewer exhaust vent several feet above the fresh air intake may be needed to prevent sewer gas entrainment. The building code requires that pollutant sources must be ten feet away from and two feet above fresh air intakes (BOCA, 1993, SBBRS, 1997).
2. Render the window frame in the courtyard classroom airtight to prevent odor penetration.
3. Seal the wall with an airtight material in the northeast classroom.
4. Remove all blockages from univents.
5. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a HEPA filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
6. Move plants away from univents in classrooms. Ensure drip pans are placed underneath plants in classrooms. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial where necessary.
7. Discontinue the use of tennis balls on chairs to prevent latex dust generation.
8. Pour water down drains to eye wash stations once a week (or more frequently if needed) in science rooms to prevent the drying of traps.

9. Consider increasing the dust-spot efficiency of univent filters. Prior to any increase of filtration, each piece of air handling equipment should be evaluated by a ventilation engineer as to whether it can maintain function with more efficient filters.
10. In order to maintain a good indoor air quality environment on the building, consideration should be give to adopting the US EPA document, “Tools for Schools”, which can be downloaded from the Internet at <http://www.epa.gov/iaq/schools/index.html>.
11. For further building-wide evaluations and advice on maintaining public buildings, see the resource manual and other related indoor air quality documents located on the MDPH’s website at <http://www.state.ma.us/dph/beha/iaq/iaqhome.htm>.

References

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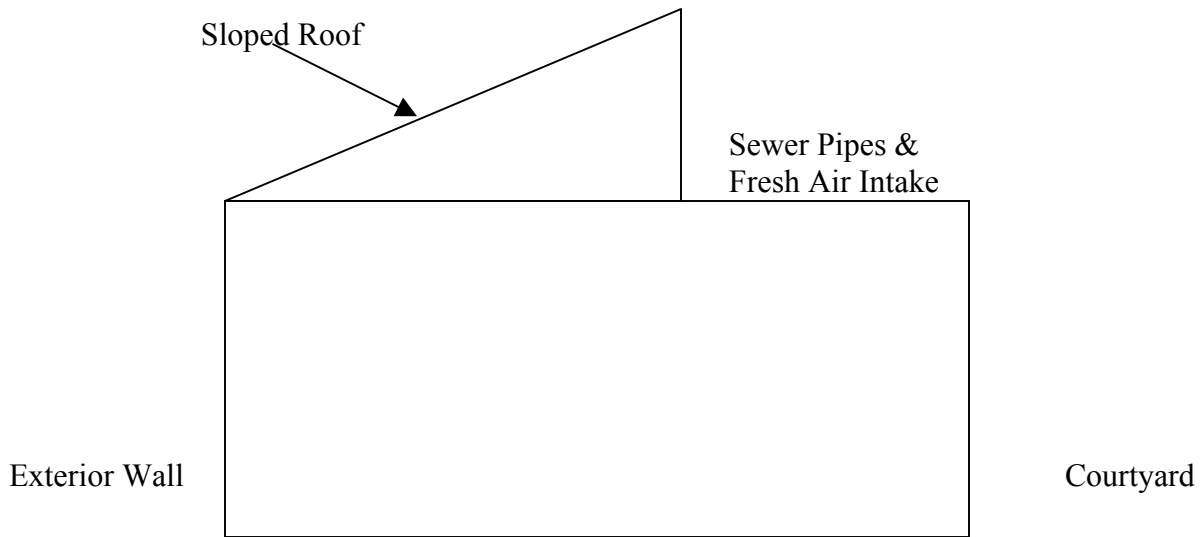
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Figure 2

**Configuration of Roof
(cross-section)**



Picture 1



Carpet Squares in front of Univent Return Vent

Picture 2



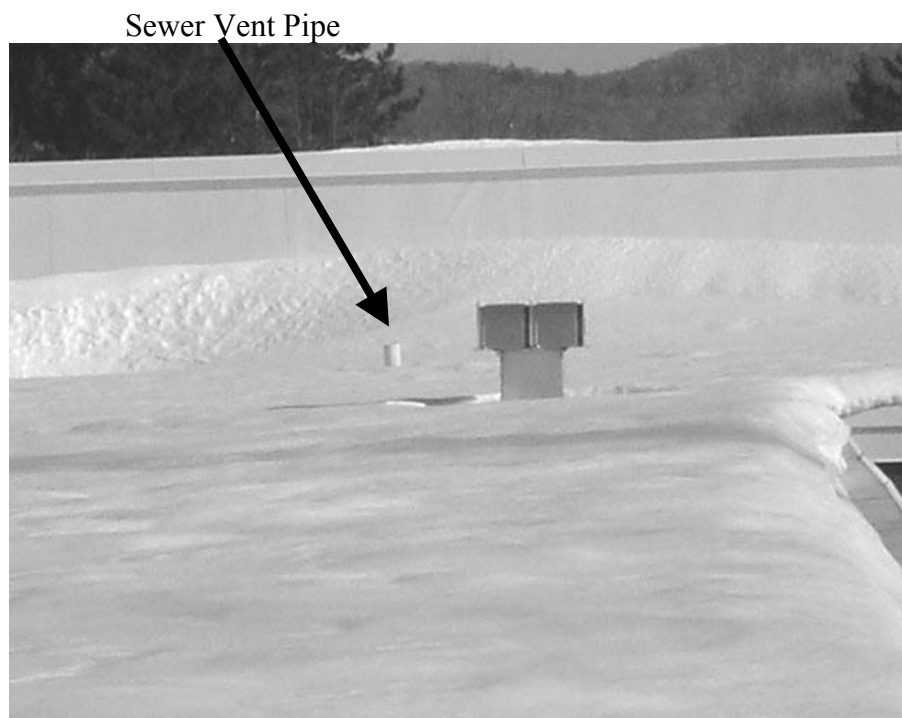
Roof Section Sloped towards Exterior Wall

Picture 3



Flat Roof Adjacent to Courtyard

Picture 4



Penthouse Roof Vent Gravity Intake, Note Location of Sewer Vent Pipe *below* Level of Fresh Air Intake

Picture 5



Open Section of Interior Wall with Drain Pipes underneath the Classroom Sink

Picture 6



Tennis Balls on Chair Legs

TABLE 1

Indoor Air Test Results –Lanesborough Elementary School - Lanesborough MA

February 27, 2003

Location	Carbon Dioxide *ppm	Temp °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Outdoors (Background)	356	35	26					
Room 209	540	72	13	3	Y	Y	Y	Tennis balls
Room 207	612	71	13	1	Y	Y	Y	Carpet odor Door open
Room 204	665	71	13	9	Y	Y	Y	Plants
Room 205	570	70	14	17	Y	Y	Y	
Room 203	604	71	14	17	Y	Y	Y	Door open
Room 201	821	69	17	20	Y	Y	Y	Tennis balls
Room 105	591	70	16	0	Y	Y	Y	Tennis balls Door open
Room 107	738	70	17	19	Y	Y	Y	Tennis balls Plants
Room 101	743	70	16	23	Y	Y	Y	Tennis balls
Room 103	763	71	17	21	Y	Y	Y	Tennis balls

* ppm = parts per million parts of air
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 1

Indoor Air Test Results –Lanesborough Elementary School - Lanesborough MA

February 27, 2003

Location	Carbon Dioxide *ppm	Temp °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Room 104	796	72	18	16	Y	Y	Y	Tennis balls
Room 102	767	72	17	15	Y	Y	Y	Tennis balls
Media Central Library	433	66	13	1	Y	Y	Y	WB
Computer Room	376	68	12	0	Y	Y	Y	22 computers
Gym	590	69	13	204	Y	Y	Y	
Art Room	606	69	13	17	Y	Y	Y	Tennis balls on shelf
Cafeteria	539	70	13	40+	Y	Y	Y	Plants
Planning Room	470	72	13	1	Y	Y	Y	Door open, photocopier Tennis balls
Room 301	561	73	13	0	Y	Y	Y	Door open
Room 303	609	73	13	0	Y	Y	Y	Plants Door open
Room 305	518	74	12	0	Y	Y	Y	Door open

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Indoor Air Test Results –Lanesborough Elementary School - Lanesborough MA**February 27, 2003**

Location	Carbon Dioxide *ppm	Temp °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Room 307	540	74	14	0	Y	Y	Y	Plants
Room 309	458	72	12	0	Y	Y	Y	Upholstery Tennis balls, door open

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